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Caractérisation des mouvements oscillants dans l'atmosphère stable d'une vallée encaissée

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In a valley sheltered from strong synoptic effects, the dynamics of the valley atmosphere at night are dominated by katabatic winds. In a stably stratified atmosphere, these winds undergo temporal oscillations, whose frequency is given by $N\sin\theta$ for an infinitely long slope of constant slope angle θ, N being the buoyancy frequency. Such an unsteady flow in a stably stratified atmosphere may also generate internal gravity waves (IGWs) (Figure 1). The numerical study by Chemel et al. (Meteorol Atmos Phys 203:187-194, 2009) showed that, in the stable atmosphere of a deep valley, the oscillatory motions associated with the IGWs generated by katabatic winds are distinct from those of the katabatic winds. The IGW frequency was found to be independent of α and about 0.8N. Their study did not consider the effects of the background stratification and valley geometry on these results. These effects are investigated in the present study for a wide range of stratification and slope angles, through numerical simulations for a deep valley. The two oscillatory systems are reproduced in the simulations. The frequency of the oscillations of the katabatic winds is found to be equal to N times the sine of the maximum slope angle. Remarkably, the IGW frequency is found to also vary as CwN, with Cw in the range 0.7 – 0.95. These values for C w are similar to those reported for IGWs radiated by any turbulent field with no dominant frequency component. Results suggest that the IGW wavelength is controlled by the valley depth.

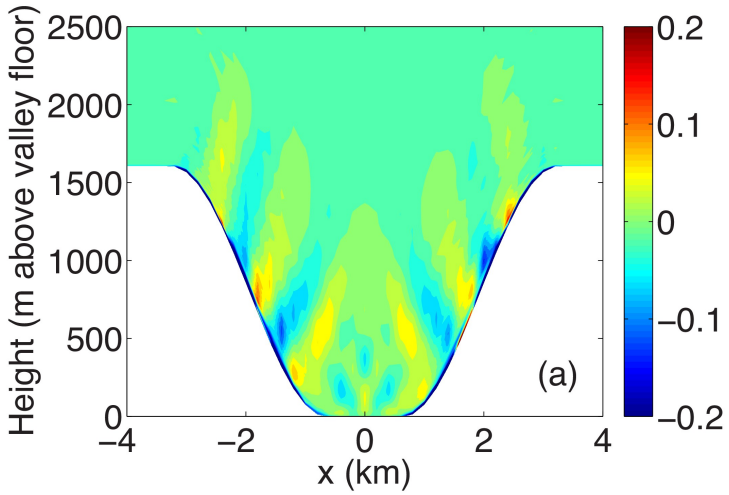

Figure 1: Vertical cross-section of a valley of idealized shape in a stably-stratified atmosphere.Contours of the vertical component of the velocity field are displayed, which attest of the generationof an internal gravity wave field from the katabatic flow (flowing along the slopes but hardly visibleon the figure). The wave amplitude is about ten times smaller than the katabatic flow amplitude.

1. Largeron Y., Staquet C. & Chemel C. 2013 Characterization of oscillating motions in the stable atmosphere of a deep valley. Boundary Layer Meteorology, DOI 10.1007/s10546-013-9825-y.